with a steam engine at some convenient place three or four hundred yards away in an adjoining road, and the electro-motors were also two Gramme machines, one on each side of the field, with their coils revolving of course backwards. Through one of these, the electric current was sent alternately, so that motion was given to one or other of two large windlasses, one on each of the waggons containing the electro-motors. In this way the plough, which could be used going in either direction, was first pulled across the field making a furrow, and then back again making another parallel furrow."

A photograph taken on the spot, of one of the complete Gramme electro-motors, with its windlass and waggon, together with the double acting plough, was projected on to the screen.

A second photograph was also now projected on to the screen of M. Chrétien's electric crane for unloading boats. This too, the lecturer said, had been successfully employed for several months at Sermaize, in the harbour there, and it was considered that a saving of about thirty per cent. had been effected of the expense formerly incurred for unloading the sugar barrels out of the boats.

Reference was then made to the difficulty that would be experienced in distributing electric power properly on account of the current in any curcuit being affected by any alteration in any other circuit connected with it, and it was explained how this difficulty was met by the electric current regulations of M. Hospitalier and Dr. Siemens. Another difficulty arising from the velocity of the water on the hill streams being great after floods and small in dry weather, and which at first sight might appear to require an extravagant supply of dynamo machines so that even in a draught sufficient power could be transmittted electrically, it was explained, could be overcome by storing up the electric energy as compressed gas, and it was shown that a square foot of hydrogen at thirty atmospheres pressure (the usual pressure in the iron gas bottles of commerce) combining with half a cubic foot of oxygen, at the same pressure, would develop no less than 110 million foot pounds of work.

Prof. Ayrton concluded by asking:—

"But is there no other side to this question? We are, it is true, a commercial people, but do we not still love our hills and our fields? There was a time when the cutler of now black, grimy, Sheffield was very fleet of foot in following the chase. There was a time when 'Not only in the villages around old Sheffield,' so says the history of Hallamshire, 'were the file-makers' shops or the smithy to be seen, with the apprentices at work; but even on the hill side in the open country, at the end of the barn would be the cutlers' shed whilst in the valley below, by the river, was the grinding wheel ready to sharpen the tools that had been manufactured.'

"And why not now? why should not that mountain air that has given you workmen of Hallamshire in past times your sinew, your independence of character, blow over your grindstone now? Why should not division of labour be carried to its end and power brought to you instead of you to the power? Let us hope then that in the next century electricity may undo whatever harm steam may have done during the last, and that the future workman of Sheffield will, instead of breathing the necessarily impure air of crowded factories, find himself again on the hill side, but with electric energy laid on at his command."

THE ANTIQUITY OF MAN

At the Sheffield meeting of the British Association Prof. Boyd Dawkins, in the course of a paper "On the Antiquity of Man," said he presented before them a diagram showing the divisions of the tertiary period, the third of the three great life periods which had been presented on the earth. When he examined those stages before the highest forms of life, he was confronted with this most important fact: in the eocene age they had not a single species of placental mammal, nor did they meet with any indications of a living placental genus. No species now found in Europe were found in the eocene age. It was absolutely impossible to suppose that man was living on the earth in eocene time, yet there was no reason, because of climate and vegetation, that he should not have been. Then they came to the miocene age, when they found not merely living families and orders, but living genera. Putting man out of the question, there was not a single well-authenticated case on record in any part of the world of any mammalian species now living on the earth having lived in the miocene age. The French preserved a flint flake which was found at Thenay, and which they say is of the miocene age; in fact it was accepted by a great majority of the French archæologists that man was living in the miocene age. The French held that flints found, and all of them bearing traces of manufacture, were of the miocene age, and the work of man. It was far less difficult to believe that these flints were the work of some of the higher and extinct forms of mokeys, than it was to believe that they were the work of man. In the pliocene age they found one or two living species making their appearance. Prof. Capelini had called attention to the fact that certain cut bones, which were asserted to be of the miocene age, had been cut by the hand of man. On one of those bones there were cuts which were done by the hand of man. The cuts were distinctly artificial, but the difficulty which presented itself to his mind was this. He was by no means certain that those bones, which were said to have been found in the pliocene strata, had been discovered in undisturbed pliocene strata. It was not clear to his mind that the mineralisation of those bones would not take place long after the pliocene age had passed away. He urged his objections to the accepting of specimens said to have been got in the pliocene age when there was no good authority for saying that such was the case. He then passed to the pleistocene, by some called the glacial period. Then living species were very abundant, extinct species very rare, and it was in that age that they met with man in considerable abundance and scattered over a very wide area. The evidence presented from time to time, in the first place out of caverns, and on the other hand out of river deposits, showed beyond a doubt that man was present in Europe in full force in the pleistocene age, and he came in just when it might be expected he would come in. In the pleistocene age they met with man as a mere hunter, not as a farmer or possessor of wild animals. He mentioned that because during the last two or three years it had been asserted that man was possessed of domestic animals in the pleistocene period. The pre-historic period which succeeded the pleistocene, was characterised by the absence of the extinct species of mammalia, with one exception. The one extinct animal which extended upward into the pre-historic age was the Irish elk. The great characteristic of the pre-historic age was the calling in of the domestic animals, the dog, sheep, horse, various breeds of hog, cattle—all coming in under the care of man, all spreading over Europe; and along with them they had the getting of cereals and fruits, and the cultivation of the arts of agriculture. They had in that period just those very things which formed the foundation of that civilisation which they themselves spread, and which had been built upon the foundations of the neolithic age. The pre-historic period was divided into the neolithic, the bronze age, and the age of iron. The pre-historic age was divided from the historic, because the former was not represented to them in historic records. In conclusion he ventured to express an opinion as to how happy they would be if they could get hold of a date and fix the antiquity of man in Europe in terms of years. It would be most delightful if they could fix the first presence of man at Creswell Crags, say within some thousands or hundreds of thousands of years. He could not help thinking that all their hopes of that description would be vain, as there were intervals, and they could not know without the written record, the duration of the intervals which separated one period from another.

UNDERGROUND TEMPERATURE[1]

The temperature of the surface of the ground is not sensibly influenced by the flow of heat upwards from below, but is determined by astronomical and atmospheric conditions. The rate of increase in travelling downwards from the surface may conveniently be called the *temperature gradient*, and averages about 1° F. for fifty or sixty feet. This is about five times as steep as the temperature gradient in the air.

If we draw isothermal surfaces for mean annual temperature in the ground, their form beneath mountains and valleys will be flatter than that of the surface above them. This is true even of the uppermost; and the flattening increases as we pass to lower ones, until at a considerable depth they become sensibly horizontal planes. The temperature gradient is consequently steeper beneath gorges and least deep beneath ridges.

In a place where the surface of the ground and the isothermal surfaces beneath it are horizontal the flow of heat will be vertical,

[1] "On some Broad Features of Underground Temperature," by Prof. J. D. Everett, F.R.S. Abstract of paper read at the Sheffield meeting of the British Association.

and the same quantity of heat will flow across all sections which lie in the same vertical. In this case the flow across a horizontal area of unit size will be equal to the product of the *temperature gradient* by the *conductivity*, if we employ the latter term in an extended sense so as to make it include convection by the percolation of water, as well as conduction proper. It follows that in comparing different strata lying in the same vertical, the gradient will vary in the converse ratio of their conductivity. It seems probable that the same law of inverse proportion between gradient and conductivity holds approximately even when the strata compared are not in the same vertical but are widely distant.

As regards the modes of observation which have been employed for the determination of gradients:—shafts full of water, and wells of large diameter, afford so much facility for equalisation of temperature by currents between the colder water above and the warmer water below, that they furnish no useful results. Even in bores of small diameter the same disturbing cause exists and always makes the observed less than the true gradient.

Observations in mines will be vitiated by the presence of pyrites, which generates heat by its slow combustion, and are also liable to be vitiated by strong currents of air; but when they are taken at the newly exposed face of a gallery which is being driven into the rock, care being taken to prevent strong air-currents at the place, and the surrounding ground not being too much honeycombed by previous excavations, good results may be obtained. A hole should be bored to the depth of about two feet in the newly exposed face, the thermometer inserted, and the hole plugged with clay.

SCIENTIFIC SERIALS

American Journal of Science and Arts, September.—In the opening paper, on the pertinacity and predominance of weeds, Prof. Asa Gray, from an examination of European weeds which have taken a strong hold on the United States, opposes Mr. Henslow's view that plants best fitted for domination as weeds are in general self-fertilised plants, and owe their predominance to this. He also regards the "greater plasticity" assumed by Prof. Claypole for European as compared with American plants as purely hypothetical.—In view of the variations in amount of oxygen in the atmosphere of a given place (sometimes by as much as one-fortieth of the average, and often the one-hundredth or two-hundredth part), Prof. Morley calls in the theory by which Prof. Loomis accounts for certain great and sudden depressions of temperature at the earth's surface, viz., by vertical descent of cold air from the higher parts of the atmosphere. The lower air at such times might well contain a less proportion of oxygen than the average. Pending systematic observations at points Prof. Loomis has indicated, the author here describes at length his method of analysis, and the results of observation on samples of air collected at home; these seem to lend some support to his theory.—A remarkable meteorite fell at Estherville, Emmel Co., Iowa, on May 10; one mass weighing 431 lbs. was found fourteen feet under the surface of the ground in a ravine, and, besides several small masses near, a mass of 151 lbs. about two miles westward. Prof. Shepard, from specimens in hand, regards this meteorite as a connecting-link between the litholites and lithosiderites, unless it be placed as a separate order in the Eucritic group of the former.—Prof. Marsh announces the discovery of two new lower jaws belonging to the genus *Dryolestes* (of Jurassic mammals).—Remaining papers:—On the colour correction of achromatic telescopes, by Mr. Harkness.—Reply to Principal Dawson on *Eozöon canadense*, by Prof. Möbius.—Terminal moraines of the North American ice-sheet (continued), by Mr. Upham.—New observations on planetoids, by Mr. Peters.—Observations on the genus Macropis, by Mr. Patton.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, September 29.—M. Daubrée in the chair.—The following papers were read:—On the development of the perturbative function in the case where, the eccentricities being small, there is any mutual inclination of the orbits, by M. Tisserand.—Construction of the international geodetic standard, and determination of its controlling weights, by MM. Sainte-Claire Deville and Debray. The method is given in detail.—Studies on the effects and mode of action of substances employed in antiseptic dressings, by MM. Gosselin and Bergeron. The method was to put blood, then pus, in contact with various antiseptic agents (including solutions of carbolic acid of various strength, camphorised alcohol, camphorised brandy), and noting the effects, both with the naked eye and with the microscope. The antiseptic agent was in some cases put in glasses with the blood or pus, sometimes applied by means of evaporation and pulverisation. The result is specified in each case; the 20 per cent. solution of carbolic acid, alcohol, and camphorised alcohol, seem to have prevented putrefaction best.—Theoretical essay on the law of Dulong and Petit; case of solid and liquid bodies and vapours, compound bodies, by M. Willotte.—Vibratory forms of bubbles of glyceric liquid, by M. Decharme. A bubble is supported on a thin watch-glass fixed at the end of a vibrating plate or rod; it follows and amplifies the vibrations, and with favourable conditions one can see distinct nodes and ventral segments, whose number varies with the velocity of vibration and diameter of the bubble. Three laws are given: (1) With a given number of nodals, the diameters of the bubbles are proportional to the lengths of the vibrating plate, or inversely proportional to the square roots of the numbers of vibrations. (2) With a given diameters of bubbles, the numbers of nodals are inversely proportional to the lengths of the vibrating plate, or directly proportional to the square roots of the numbers of vibrations. (3) With a given length of vibrating rod, the numbers of nodals are proportional to the diameters of the bulbs. These experiments generalise that of Melde by extending it to spherical surfaces, and even to volumes, for the author has found that thin balloons of caoutchouc filled with water behave like bubbles.—On the presence of alcohol in the animal tissues during life and after death, in the case of putrefaction, from the physiological and toxicological point of view, by M. Bechamp. Horse-flesh (3 kg.) plunged for ten minutes in boiling water, to coagulate the surface, then inclosed in a vessel, was examined after a month. About 0·8 gr. of alcohol was got from the interior, and 10 gr. of salts (acetate, butyrate, &c.) of soda. (There were numerous bacteria; no vibrion.) 4 kg. left to itself four days gave less alcohol. Thus putrefaction is essentially similar to fermentation; and specially so to butyric. M. Bechamp also found alcohol in various healthy animal tissues (brain, muscles, and liver).—Action of sulphide of carbon liberated in a slow and prolonged way on the vine, by M. Rohart. This is more efficacious than the brief application, and does not injure the plant.—Discovery of two small planets by Mr. Peters.—Action of metallic nitrates on monohydrated nitric acid, by M. Ditte.—Thermal study of succinic acid and its derivatives, by M. Chroustchoff.—On a new curare extracted from only one plant, *Strychnos triplinervia*, by MM. Couty and De Lacerda. This is less active than the other, but easy to obtain in large quantity. It gives in a few seconds a curarisation which may be arrested in its different periods.

CONTENTS